

# Measures of Racial/Ethnic Health Disparities in Cancer Mortality Rates and the Influence of Socioeconomic Status

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**Objectives:** In the 1990s, U.S. cancer mortality rates declined due to reductions in tobacco use among men and beneficial cancer interventions, such as mammography and Pap smears. We examined the cancer rates by racial/ethnic group, socioeconomic status and time period to identify disparities underlying the overall mortality trend.

**Methods:** We examined racial/ethnic disparities by measuring excess cancer burden [rate ratio (RR) and ratio differences (RD)] and trends in their cancer rates for nine cancer sites. The trend (T) is calculated as a ratio of the average annual cancer mortality rate for 1995–2000 relative to the rate for 1990–1994 for three levels of poverty (counties with <10% living below the poverty level, 10%–<20% and ≥20%) for the major racial/ethnic populations. We also compared the trend for each racial/ethnic SES group to the trend for lowest SES white group (TD).

**Results:** Blacks have RR disparities relative to whites for each cancer site examined, except for female lung cancer, while the other minorities had RR disparities for cervical cancer (RR>1). There are increases in RR disparities from 1990–1994 to 1995–2000 (RD>0) for colorectal cancer, prostate cancer and breast cancer for each racial/ethnic minority. Whites and blacks had declining trends for every SES group (T<1) and positive high SES gradients (the highest SES group had the best trend and the lowest SES group had the worst trend) at each cancer site, except female lung cancer (T>1). In contrast, American Indians/Alaska natives, Hispanics and Asians/Pacific Islanders had increasing trends for some of their cancer sites, and their trends did not have the SES gradients.

**Conclusions:** Increases in racial/ethnic disparities (RD>0) for colorectal, breast and prostate cancer were largest in the lowest SES groups. At some cancer sites, the highest SES group for minorities had worse trend results than the trends for the lowest SES white group (TD>0).

**Key words:** race/ethnicity ■ health disparities ■ cancer ■ mortality ■ socioeconomic status

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## INTRODUCTION

In 2003, the NCI Surveillance, Epidemiology and End Results Program (SEER) reported on cancer statistics by socioeconomic status (SES) for the major racial/ethnic populations for the period 1995–1999.<sup>1</sup> SES was represented by three levels of poverty. Those levels included counties with <10% of the population of the county living below the poverty level (determined from the 1990 Census), counties with 10%–<20% living below the poverty level, and counties with ≥20% living below the poverty level.<sup>1</sup> Those living in counties with >20% living below the poverty level had 13% higher cancer mortality for men and a 3% higher rate for women than those living in counties with <10% living below the poverty level.<sup>2</sup>

The cancer mortality rates for all races by socioeconomic status and gender were level from 1990 until 1994, then began to decline.<sup>1</sup> These changes created a natural break to compare changes in average annual rates in the early 1990s with rates in the late 1990s for the major racial/ethnic groups by socioeconomic status. In this study, we examine changes in average annual cancer mortality rates for the major racial/ethnic populations for the period 1990–1994 to 1995–2000 by SES, using the same database that was used for the SEER SES report.<sup>1</sup>

## METHODS

Cancer mortality rates for whites, blacks, American Indians and Alaska natives (AIs/ANs) and Asians and Pacific Islanders (PIs) and Hispanics are from the National Center for Health Statistics based on death certificate reporting of race and ethnicity.<sup>3</sup> Information and data on the populations with incomes under the poverty levels are from the 1990 Census county level data taken by the U.S. Census Bureau.<sup>4</sup>

The poverty rate was used to measure the socioeconomic status of the population. It measured the percentage of population below the poverty level. The poverty

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level refers to the percentage of families or individuals classified as being below the official poverty thresh-

old. In the 1990 decennial census, the official poverty threshold for a family of four was \$12,674, and 12.8%

**Table 1. Male cancer mortality rates and rate ratios by socioeconomic status**

<b>Cancer Site</b>	<b>Poverty Level</b>	<b>R</b>	<b>R</b>		
<b>Whites/Males</b>		<b>1990-1994</b>	<b>1995-2000</b>		
All Cancers	All Levels	268.8	251.4		
	<10% below poverty	262.2	243.7		
	10-19.9% below poverty	270.4	253.4		
	≥20% below poverty	280.6	264.6		
Colorectum	All Levels	28.9	25.6		
	<10% below poverty	29.7	25.6		
	10-19.9% below poverty	28.8	25.6		
	≥20% below poverty	27.8	25.8		
Lung	All Levels	86.2	78.8		
	<10% below poverty	79.3	72.3		
	10-19.9% below poverty	88.1	80.6		
	≥20% below poverty	97.0	89.2		
Prostate	All Levels	36.1	30.8		
	<10% below poverty	36.8	30.8		
	10-19.9% below poverty	36.0	30.9		
	≥20% below poverty	34.9	30.8		
		<b>R</b>	<b>R</b>	<b>RR</b>	<b>RR</b>
<b>Blacks/Males</b>		<b>1990-1994</b>	<b>1995-2000</b>	<b>1990-1994</b>	<b>1995-2000</b>
All Cancers	All Levels	392.7	359.8	1.461	1.431
	<10% below poverty	374.9	331.8	1.430	1.362
	10-19.9% below poverty	399.1	365.2	1.476	1.441
	≥20% below poverty	393.2	367.8	1.401	1.390
Colorectum	All Levels	36.2	34.9	1.253	1.363
	<10% below poverty	34.8	32.9	1.172	1.285
	10-19.9% below poverty	37.0	35.8	1.285	1.398
	≥20% below poverty	35.6	34.3	1.281	1.329
Lung	All Levels	122.0	108.5	1.415	1.377
	<10% below poverty	113.8	94.3	1.435	1.304
	10-19.9% below poverty	125.2	111.5	1.421	1.383
	≥20% below poverty	121.6	111.6	1.254	1.251
Prostate	All Levels	79.6	73.8	2.205	2.396
	<10% below poverty	80.1	72.2	2.177	2.344
	10-19.9% below poverty	80.1	73.0	2.225	2.362
	≥20% below poverty	78.8	76.2	2.258	2.474
		<b>R</b>	<b>R</b>	<b>RR</b>	<b>RR</b>
<b>American Indians/Alaska Natives/Males</b>		<b>1990-1994</b>	<b>1995-2000</b>	<b>1990-1994</b>	<b>1995-2000</b>
All Cancers	All Levels	167.4	172.0	0.623	0.684
	<10% below poverty	193.5	198.2	0.738	0.813
	10-19.9% below poverty	151.8	153.4	0.561	0.605
	≥20% below poverty	178.6	188.0	0.636	0.711
Colorectum	All Levels	14.0	17.9	0.484	0.699
	<10% below poverty	21.3	23.5	0.717	0.918
	10-19.9% below poverty	13.4	15.9	0.465	0.621
	≥20% below poverty	12.0	18.5	0.432	0.717
Lung	All Levels	51.6	53.1	0.599	0.674
	<10% below poverty	58.4	70.1	0.736	0.970
	10-19.9% below poverty	50.4	47.2	0.572	0.586
	≥20% below poverty	51.3	53.6	0.529	0.601
Prostate	All Levels	23.4	21.9	0.648	0.711
	<10% below poverty	23.0	18.9	0.625	0.614
	10-19.9% below poverty	20.9	21.4	0.581	0.693
	≥20% below poverty	27.5	24.3	0.788	0.789

of the U.S. population was below this poverty level.<sup>1</sup> The socioeconomic status measures used were three levels of poverty, counties with <10% living below the poverty level (<10% poverty), with 10–<20% living below the poverty level (10–<20% poverty) and with ≥20% or more living below the poverty level (≥20% poverty), respectively.<sup>1</sup>

The same database that was used for the SEER SES report is used for this study.<sup>5</sup> Cancer mortality rates are available from 1900–2000 for this database. Since there is a natural change in the cancer mortality rates from 1990–1994 and 1995–2000 for all races, we determined average annual cancer mortality rates for these two periods for all counties, counties with <10% poverty, 10–<20% poverty and ≥20% poverty. Then we used these age-adjusted rates, standardized to the 2000 U.S. population, for our study.<sup>6</sup>

## Measurement of Disparities

Racial/ethnic disparities can be measured in a number of ways.<sup>7–10</sup> The most traditional way is to measure the excess cancer burden in a racial/ethnic group as compared to a reference group. If racial/ethnic group rates are available for two time periods, a common way to measure disparities is a ratio of the racial/ethnic group rate to the reference group rate for the same time period, cancer site, gender and SES group. The rate ratio (RR) disparity measure is given as:

$$RR (SES, \text{min}, \text{yr}) = R (SES, \text{min}, \text{yr}) / R (SES, \text{white}, \text{yr})$$

where  $RR > 1$ , rate for minority group is larger than rate for reference group—RR disparity; and  $RR < 1$ , rate for minority group is smaller than the rate for the reference group where  $R (SES, \text{min}, \text{yr})$  and  $R (SES, \text{white}, \text{yr})$  are the rates for one of the SES groups, min = racial/ethnic

Table 1. continued

		R	R	RR	RR
		1990–1994	1995–2000	1990–1994	1995–2000
<b>Asians or Pacific Islanders/Males</b>					
All Cancers	All Levels	170.0	156.2	0.632	0.621
	<10% below poverty	173.6	158.4	0.662	0.650
	10–19.9% below poverty	167.4	153.9	0.619	0.607
	≥20% below poverty	166.0	158.1	0.592	0.598
Colorectum	All Levels	18.0	16.1	0.623	0.629
	<10% below poverty	19.2	15.9	0.646	0.621
	10–19.9% below poverty	16.9	16.0	0.587	0.625
	≥20% below poverty	18.3	17.3	0.658	0.671
Lung	All Levels	45.3	40.9	0.526	0.519
	<10% below poverty	45.2	40.3	0.570	0.557
	10–19.9% below poverty	45.0	41.1	0.511	0.510
	≥20% below poverty	48.0	44.1	0.495	0.494
Prostate	All Levels	17.2	14.5	0.476	0.471
	<10% below poverty	19.3	16.4	0.524	0.532
	10–19.9% below poverty	15.6	13.1	0.433	0.424
	≥20% below poverty	15.1	12.1	0.433	0.393
		R	R	RR	RR
		1990–1994	1995–2000	1990–1994	1995–2000
<b>Hispanics/Males</b>					
All Cancers	All Levels	177.0	177.2	0.658	0.705
	<10% below poverty	147.8	154.4	0.564	0.634
	10–19.9% below poverty	178.3	175.9	0.659	0.694
	≥20% below poverty	191.7	196.3	0.683	0.742
Colorectum	All Levels	17.7	18.3	0.612	0.715
	<10% below poverty	17.6	15.9	0.593	0.621
	10–19.9% below poverty	18.0	18.4	0.625	0.719
	≥20% below poverty	17.2	19.4	0.619	0.752
Lung	All Levels	42.6	40.7	0.494	0.516
	<10% below poverty	33.4	33.8	0.421	0.467
	10–19.9% below poverty	43.2	40.7	0.490	0.505
	≥20% below poverty	46.9	45.3	0.484	0.508
Prostate	All Levels	25.9	24.8	0.717	0.805
	<10% below poverty	22.5	22.0	0.611	0.714
	10–19.9% below poverty	26.3	24.5	0.731	0.793
	≥20% below poverty	26.7	27.1	0.765	0.880

minority group and yr = 1990–1994 or 1995–2000.

Another important measure of disparities is to determine if the magnitudes of the RR disparities increase over time. The difference of the RR disparities for periods 1995–2000 and 1990–1994 measures this change. This difference is called the ratio differences (RD) and is given as:

$$RD (SES, min) = RR (SES, min, 1995-2000) - RR (SES, min, 1990-1994)$$

where  $RD > 0$ , the magnitude of the RR disparities have increased from 1990–1994 to 1995–2000—that is, the RR disparities have increased over this period of time; and  $RD < 0$ , the magnitude of the RR disparities have declined from 1990–1994 to 1995–2000—that is, the RR disparities have declined over this period, where  $RR (SES, min, 1995-2000)$  and  $RR (SES, min, 1990-1994)$  are the RRs for a SES group from a min = racial/ethnic minority for 1995–2000 or 1990–1994.

Measuring disparities is the first step in their identification, but it is necessary to understand the causes of the

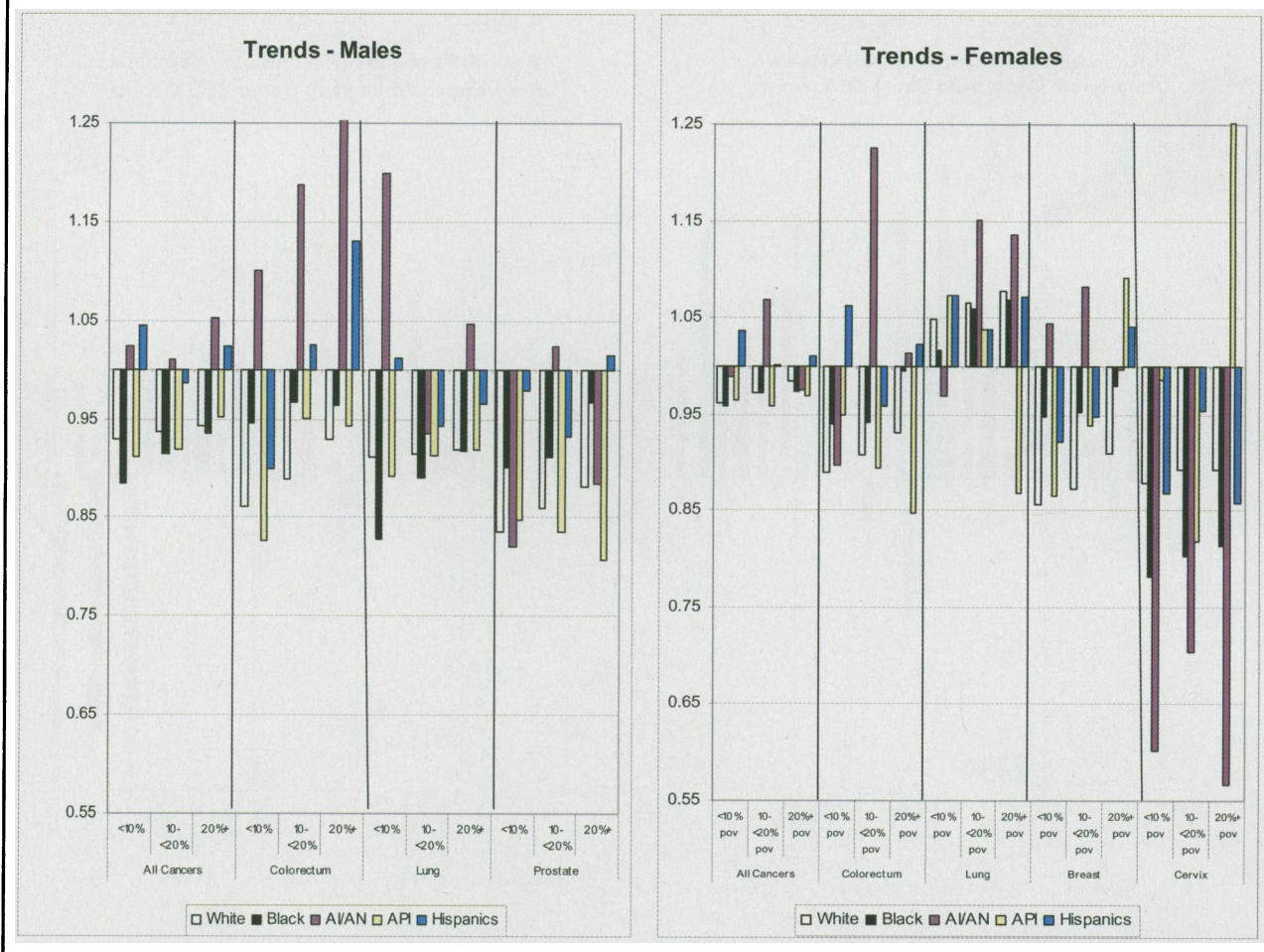
disparities. Examining the trends for the racial/ethnic groups allows one to explore the causes of their disparities. Since we have two points in time, we used the ratio of their rates to measure the trend (referred to as T values for the trend). In this case, the T value is also a RR:

$$T (SES, group) = R (SES, group, yr = 1995-2000) / R (SES, group, yr = 1990-1994)$$

where  $T > 1$ , rates increased from 1990–1994 to 1995–2000—increasing trend; and  $T < 1$ , rates declined from 1990–1994 to 1995–2000—declining trend; where  $R (SES, group, yr)$  is the rate of a given cancer site for the SES group of a racial/ethnic group, by gender for yr=1990–1994 or 1995–2000.

To determine if the progress for the racial/ethnic minorities is comparable to that of a reference group, we compared the trend for a SES group within a racial/ethnic group to the trend for a reference group. In this project, we used the white group with  $\geq 20\%$  living below the poverty level as the reference group since they have the smallest declining trends among all the white SES

**Figure 1. Trends (T values) for male and female racial/ethnic groups.  $T > 1$ , increasing trends.  $T < 1$ , declining trends**



groups. This is called the trend difference (TD):

$$TD = T(\text{SES, min}) - T(\text{SES, reference}) = T(\text{SES, min}) - T(\geq 20\% \text{ with poverty, white})$$

where  $TD > 0$ , trend for minority is worse than reference group trend–trend disparity; and  $TD < 0$ , trend for minority population is better than reference group trend; where  $T(\text{SES, min})$  and  $T(\text{SES, reference})$  are the trend values for the SES groups of a racial/ethnic minority and of the reference group, respectively, for the same cancer site and gender.

## Determining SES Gradients in the Trend

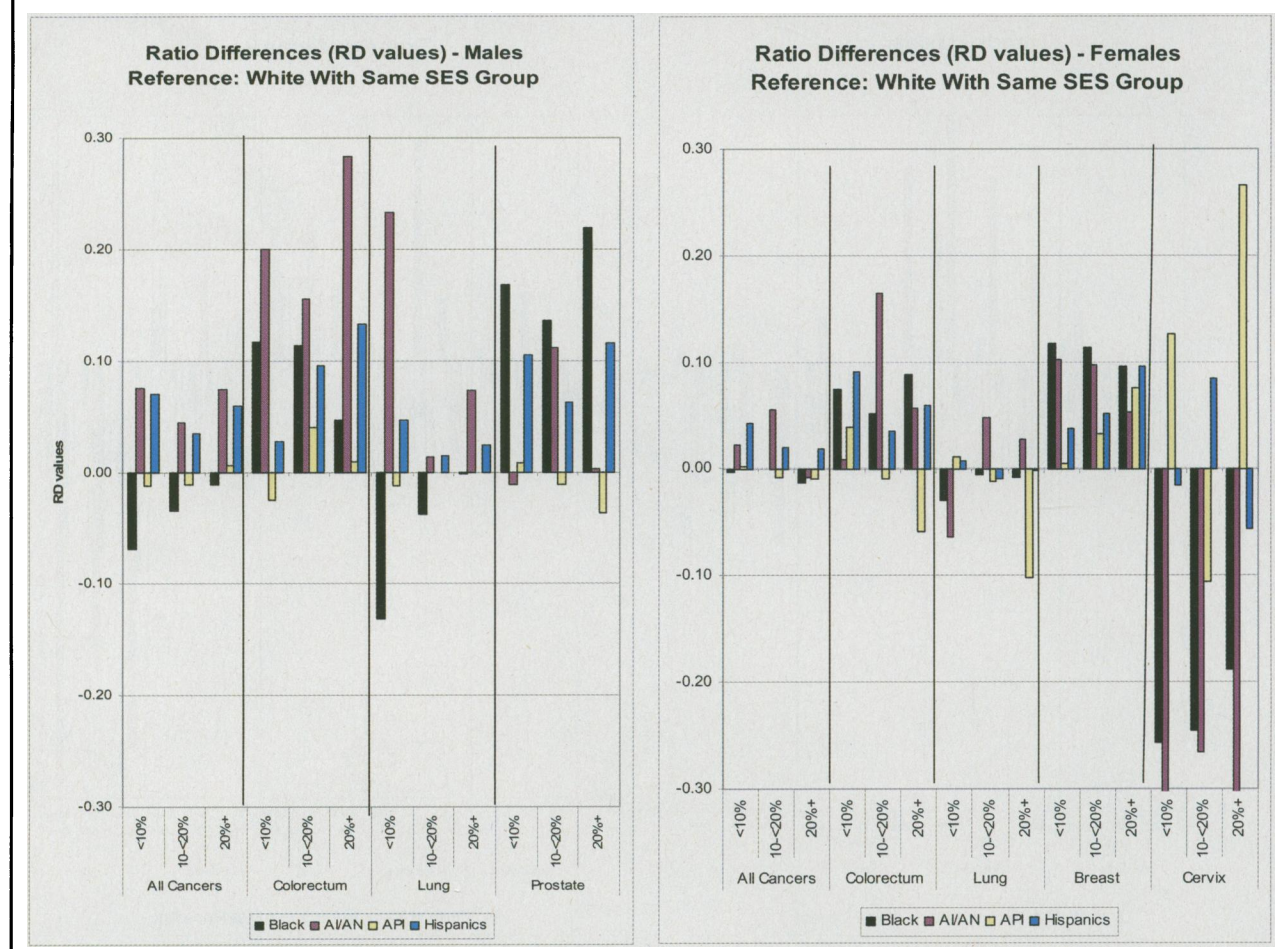
For the trend measures, one can determine which of the three SES groups have the best outcome and the worse outcome. For example, if all three groups have declining trends, the SES group with the best outcome is the group with the largest decline, while the SES group with the worse outcome is the group with the smallest decline. If all three groups have increases, then the SES group with the best outcome is the group with the smallest increase and the SES group with the worse out-

come is the group with the largest increase. Once the SES groups with the best and worse outcomes are identified, then one can label the patterns associated with SES. When the highest-SES group has the best outcome and the lowest-SES group has the worse outcome, one can term this effect a “positive high-SES gradient.” On the other hand, if the lowest-SES group had the best outcome and the highest SES had the worse outcome, the graded response would be called a “positive low-SES gradient,” indicating that the lowest-SES group had the best outcome. This terminology will be used to describe the SES gradients.

## RESULTS

The annual cancer mortality rates (Rs) and the RRs (RR values) for the periods 1990–1994 and 1995–2000 for whites, blacks, AIs/ANs, Asians/Pis, and Hispanics for all counties, counties with  $<10\%$  living below poverty,  $10\text{--}<20\%$  living below poverty and  $\geq 20\%$  living below poverty are reported in Table 1 for males and Table 2 for females. RR values of  $>1$  ( $RR > 1$ ) indicate an excess cancer burden for the racial/ethnic group. Figure 1 plots the trends (T values) from 1990–1994 to 1995–2000 for

**Figure 2. Ratio differences (RD values) for male and female racial/ethnic groups.  $RD > 0$ , rate ratio disparities are increasing from 1990–1994 to 1995–2000.  $RD < 0$ , rate ratio disparities are declining over this period**



**Table 2. Female cancer mortality rates and rate ratios by socioeconomic status**

<b>Cancer Site</b>	<b>Poverty Level</b>	<b>R</b>	<b>R</b>		
<b>Whites/Females</b>		<b>1990–1994</b>	<b>1995–2000</b>		
All Cancers	All	172.8	167.7		
	<10% below poverty	174.5	167.8		
	10–19.9% below poverty	172.5	167.7		
	≥20% below poverty	170.7	168.2		
Colorectum	All	19.5	17.7		
	<10% below poverty	20.1	17.9		
	10–19.9% below poverty	19.3	17.6		
	≥20% below poverty	18.8	17.5		
Lung	All	39.0	41.4		
	<10% below poverty	39.2	41.1		
	10–19.9% below poverty	39.1	41.7		
	≥20% below poverty	37.9	40.9		
Breast	All	31.7	27.6		
	<10% below poverty	32.9	28.2		
	10–19.9% below poverty	31.4	27.4		
	≥20% below poverty	30.0	27.3		
Cervix	All	3.0	2.7		
	<10% below poverty	2.5	2.2		
	10–19.9% below poverty	3.2	2.8		
	≥20% below poverty	3.9	3.5		
		<b>R</b>	<b>R</b>	<b>RR</b>	<b>RR</b>
<b>Blacks/Females</b>		<b>1990–1994</b>	<b>1995–2000</b>	<b>1990–1994</b>	<b>1995–2000</b>
All Cancers	All	205.8	199.6	1.191	1.190
	<10% below poverty	199.0	190.8	1.140	1.137
	10–19.9% below poverty	209.5	203.6	1.214	1.214
	≥20% below poverty	203.5	198.2	1.192	1.178
Colorectum	All	25.9	24.8	1.328	1.401
	<10% below poverty	25.9	24.4	1.289	1.363
	10–19.9% below poverty	26.7	25.2	1.383	1.432
	≥20% below poverty	24.5	24.3	1.303	1.389
Lung	All	37.7	39.8	0.967	0.961
	<10% below poverty	37.5	38.2	0.957	0.929
	10–19.9% below poverty	39.3	41.6	1.005	0.998
	≥20% below poverty	35.3	37.7	0.931	0.922
Breast	All	37.8	36.3	1.192	1.315
	<10% below poverty	36.3	34.4	1.103	1.220
	10–19.9% below poverty	38.6	36.8	1.229	1.343
	≥20% below poverty	37.3	36.6	1.243	1.341
Cervix	All	7.6	6.0	2.533	2.222
	<10% below poverty	5.8	4.6	2.320	2.091
	10–19.9% below poverty	7.7	6.1	2.406	2.179
	≥20% below poverty	8.4	6.8	2.154	1.943
		<b>R</b>	<b>R</b>	<b>RR</b>	<b>RR</b>
<b>American Indians/Alaska Natives/Females</b>		<b>1990–1994</b>	<b>1995–2000</b>	<b>1990–1994</b>	<b>1995–2000</b>
All Cancers	All	114.1	116.2	0.660	0.693
	<10% below poverty	131.4	130.1	0.753	0.775
	10–19.9% below poverty	97.1	103.8	0.563	0.619
	≥20% below poverty	132.0	128.7	0.773	0.765
Colorectum	All	11.6	12.5	0.595	0.706
	<10% below poverty	19.9	17.9	0.990	1.000
	10–19.9% below poverty	9.1	11.1	0.472	0.631
	≥20% below poverty	12.0	12.2	0.638	0.697
Lung	All	23.7	26.2	0.608	0.633
	<10% below poverty	33.5	32.5	0.855	0.791
	10–19.9% below poverty	23.5	27.0	0.601	0.647
	≥20% below poverty	19.3	21.9	0.509	0.535

each SES group of the racial/ethnic populations, with a graph for males and one for females. T values of >1

(T>1) indicate that trends are increasing. The RR differences (RD values) are plotted in Figure 2. Positive RD

**Table 2. continued**

		R	R	RR	RR
<b>American Indians/Alaska Natives/Females</b>		<b>1990–1994</b>	<b>1995–2000</b>	<b>1990–1994</b>	<b>1995–2000</b>
Breast	All	14.3	14.9	0.451	0.540
	<10% below poverty	15.3	16.0	0.465	0.567
	10–19.9% below poverty	12.6	13.7	0.401	0.500
	≥20% below poverty	16.6	16.6	0.553	0.608
Cervix	All	4.9	3.1	1.633	1.148
	<10% below poverty	3.3	2.0	1.320	0.909
	10–19.9% below poverty	3.9	2.8	1.219	1.000
	≥20% below poverty	7.3	4.1	1.872	1.171
		R	R	RR	RR
<b>Asians or Pacific Islanders/Females</b>		<b>1990–1994</b>	<b>1995–2000</b>	<b>1990–1994</b>	<b>1995–2000</b>
All Cancers	All	106.9	102.8	0.619	0.613
	<10% below poverty	108.5	104.7	0.622	0.624
	10–19.9% below poverty	106.0	101.6	0.614	0.606
	≥20% below poverty	103.0	99.9	0.603	0.594
Colorectum	All	12.1	11.1	0.621	0.627
	<10% below poverty	11.7	11.1	0.582	0.620
	10–19.9% below poverty	12.5	11.2	0.648	0.636
	≥20% below poverty	12.4	10.5	0.660	0.600
Lung	All	18.6	19.4	0.477	0.469
	<10% below poverty	18.5	19.8	0.472	0.482
	10–19.9% below poverty	18.7	19.4	0.478	0.465
	≥20% below poverty	19.9	17.3	0.525	0.423
Breast	All	13.9	12.7	0.438	0.460
	<10% below poverty	15.0	13.0	0.456	0.461
	10–19.9% below poverty	13.2	12.4	0.420	0.453
	≥20% below poverty	11.5	12.6	0.383	0.462
Cervix	All	3.3	3.0	1.100	1.111
	<10% below poverty	2.6	2.6	1.040	1.182
	10–19.9% below poverty	4.0	3.3	1.250	1.179
	≥20% below poverty	2.6	3.3	0.667	0.943
		R	R	RR	RR
<b>Hispanics/Females</b>		<b>1990–1994</b>	<b>1995–2000</b>	<b>1990–1994</b>	<b>1995–2000</b>
All Cancers	All	110.8	111.4	0.641	0.664
	<10% below poverty	94.6	98.1	0.542	0.585
	10–19.9% below poverty	111.0	111.1	0.643	0.662
	≥20% below poverty	120.6	121.9	0.707	0.725
Colorectum	All	11.6	11.4	0.595	0.644
	<10% below poverty	9.4	9.9	0.468	0.553
	10–19.9% below poverty	12.2	11.7	0.632	0.665
	≥20% below poverty	11.3	11.6	0.601	0.663
Lung	All	14.2	14.9	0.364	0.360
	<10% below poverty	12.7	13.6	0.324	0.331
	10–19.9% below poverty	14.1	14.6	0.361	0.350
	≥20% below poverty	15.2	16.3	0.401	0.399
Breast	All	18.6	18.0	0.587	0.652
	<10% below poverty	16.3	15.0	0.495	0.532
	10–19.9% below poverty	18.7	17.8	0.596	0.650
	≥20% below poverty	20.0	20.8	0.667	0.762
Cervix	All	4.2	3.9	1.400	1.444
	<10% below poverty	3.3	2.8	1.320	1.273
	10–19.9% below poverty	4.0	3.8	1.250	1.357
	≥20% below poverty	5.6	4.8	1.436	1.371

values indicate increases in the magnitude of RR disparities from 1990–1994 to 1995–2000—that is, RR disparities are increasing over the time period ( $RD > 0$ ). The trend differences (TD values) are graphed in Figure 3. Positive TD values indicate the trend for the whites with  $\geq 20\%$  living in poverty is better than the trend for the SES group of a racial/ethnic population ( $TD > 0$ ).

## Blacks

Blacks have higher rates than those for whites and therefore have RR disparities for each cancer site ( $RR > 1$ ), except female lung cancer ( $RR < 1$ ) (Table 1 and 2, blacks). The positive ratio differences ( $RD > 0$ ) indicate that RR disparities are increasing from 1990–1994 to 1995–2000 for male and female colorectal cancers, prostate cancer and breast cancer (Figure 2, blacks). In contrast, all cancers, and lung cancers for males and females and cervical cancers showed declines in their RR disparities ( $RD < 0$ ). Whites and blacks had declining trends ( $T < 1$ ) for every SES group at each cancer site, except for female lung cancer ( $T > 1$ ) (Figure 1, blacks). For each cancer site, whites and blacks in general had

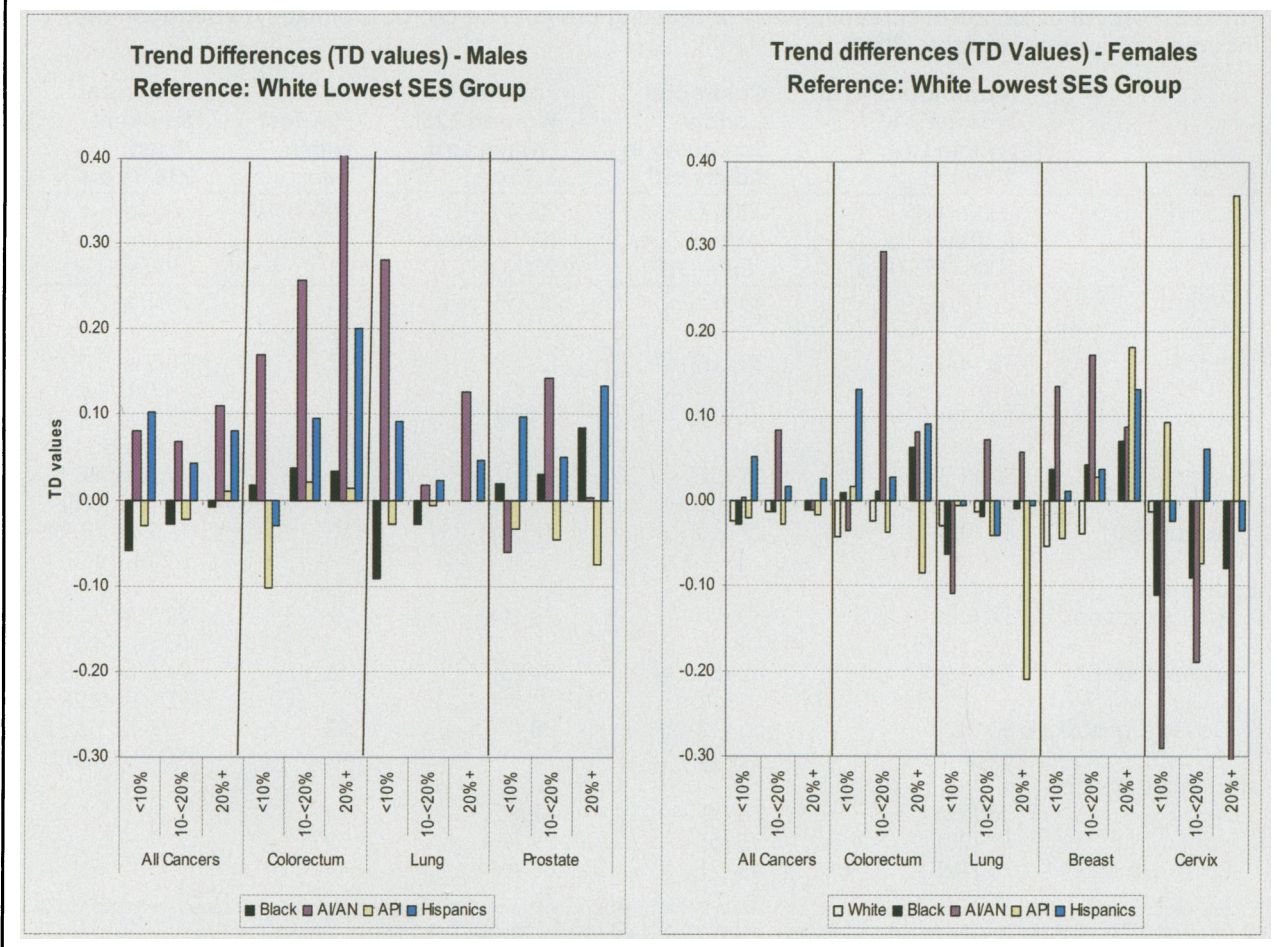
a “positive high-SES gradient,” with the highest-SES group having the best trends (largest declining trends or smallest increasing trend for female lung cancer) and the lowest-SES groups having the worst trends (smallest declines or largest increase for female lung cancer)—that is, for whites and blacks, the changes in mortality rates had “positive high-SES gradients.” See the stepwise SES gradients for whites and blacks in Figure 1.

The positive trend differences ( $TD > 0$ ) indicate that the trends for any SES group for black prostate cancer, male and female colorectal cancers, and breast cancer, including the highest black SES groups, are worse than the trends for whites with  $\geq 20\%$  poverty (Figure 3, blacks).

## American Indians and Alaska Natives

AIs/ANs have RR disparities for cervical cancer ( $RR > 1$ ) (Table 1 and 2, AIs/ANs). The positive ratio differences ( $RD > 0$ ) indicate that RR disparities are increasing from 1990–1994 to 1995–2000 in  $\geq 2$  of the three SES groups for each cancer site, except cervical cancer ( $RD < 0$ ) (Figure 3, AIs/ANs).

**Figure 3. Trend differences (TD values) for male and female racial/ethnic groups.  $TD > 0$ , trend for group is worse than trend for whites with 20%+ living in poverty.  $TD < 0$ , trend for group is better than trend for whites with 20%+ living in poverty**



Unlike white and blacks that had declining trends for all the SES groups (except female lung cancer), AI/ANs had increasing trends ( $T>1$ ) in  $\geq 2$  of the three SES groups at each cancer site except for female all cancers, cervical and prostate cancer, where  $\geq 2$  of the three SES groups had declines ( $T<1$ ). In six cancer sites, the middle-SES group (10–<20% poverty) had the worst outcomes, particularly for females (Figure 1, AI/ANs). Because of the strong influence of the middle-SES groups, there was little evidence of consistent SES gradients in the AI/AN data.

The positive trend differences ( $TD>0$ ) indicate that  $\geq 2$  of three SES groups for AI/ANs all cancers, colorectal and lung for males and females, and breast and prostate had trends that were worse than the trends for whites with  $\geq 20\%$  living below poverty (Figure 3, AI/ANs).

## Asians and Pacific Islanders

Asians/PIs have RR disparities for cervical cancer ( $RR>1$ ). The positive ratio differences ( $RD>0$ ) indicate that RR disparities are increasing from 1990–1994 to 1995–2000 in  $\geq 2$  of the three SES groups for male colorectal, breast and cervical cancers (Figure 3, Asians/PIs). In contrast, all cancers and lung cancer for males and females, prostate cancers and female colorectal cancers had negative

ratio differences for  $\geq 2$  of the three SES groups ( $RD<0$ ), indicating rate disparities declined over this period.

Asians/PIs had increasing trends ( $T>1$ ) in the highest- and middle-SES groups for female lung cancer and the lowest-SES group for breast and cervical cancer. Asians/PIs had declining trends ( $T<1$ ) for all SES groups for all cancers and colorectal cancer in males and females, male lung and prostate cancers, and in the highest- and middle-SES groups for breast and cervical cancers. There are “positive high-SES gradients” for male all cancers and lung cancer and female breast cancer. In addition, there were three cancer sites where the lowest-SES group had the best trends and the highest SES had the worse trends, prostate and female colorectal and lung cancers (Figure 1, Asians/PIs). We term this pattern a “positive low-SES gradient.”

The positive trend differences ( $TD>0$ ) indicate that for Asian/PI male colorectal cancer, breast and cervical cancers  $\geq 2$  of the three SES groups had trends that were worse than the trends for whites with  $\geq 20\%$  poverty (Figure 3, Asians/PIs).

## Hispanics

Hispanics have RR disparities for cervical cancer ( $RR>1$ ). The positive ratio differences ( $RD>0$ ) indicate

**Table 3. Percent utilization of screening tests or smoking prevalence by race/ethnicity, education and income and insurance status, 2000**

	Mammograms in Women $\geq 40$ (Within Last 2 Years)	Colorectal Cancer Screening in Adults $\geq 50$	Pap Test in Women $\geq 25$ (Within Last 3 Years)	PSA Test Within Year	% Current Smokers Aged $\geq 18$ Years*
Racial/Ethnic Group	2000 NHIS (Difference 2000–1987)	2000 NHIS (Difference 2000–1987)	2000 NHIS (Difference 2000–1987)	2000 NHIS	2004 (Difference 1995–2004)
White	71 (41)	40 (12)	83 (9)	42	24.1 M 20.4 F (-3.0) (-3.7)
Black	68 (44)	38 (18)	84 (7)	37	23.9 M 17.2 F (-14.9) (-6.3)
AI/AN	52 (33)	41 (22)	75 (-5)	28	37.3 M 29.5 F (0.0) (-5.9)
Asian	59 (43)	35 (21)	71 (10)	26	17.8 M 4.8 F (-11.6) (0.5)
Hispanic	61 (43)	27 (10)	77 (13)	30	18.9 M 10.9 F (-2.8) (-4.0)
Education					
< High school	57 (40)	30 (10)	74 (11)	29	29.9 M 21.9 F (-3.8) (-4.3)
Some college	73 (36)	42 (8)	84 (6)	46	24.8 M 20.3 F (-0.1) (-2.2)
College graduate	80 (42)	50 (10)	88 (7)	52	13.5 M 10.1 F (-0.8) (-3.6)
Health Insurance					
None	38 (16)	18 (4)	62 (-2)	13	
Public	62 (23)	35 (5)	79 (9)	33	
Private/military	75 (12)	43 (7)	86 (6)	44	

Colorectal screening: home or office blood stool test within the last year or colorectal endoscopy within the last three years; M: Males  
F: Females; \*\* For this column only: white is white, non-Hispanic, black is black non-Hispanic

that RR disparities are increasing from 1990–1994 to 1995–2000 in the three SES groups for each cancer site, except female lung and cervical cancer, where two of the three SES groups had negative ratio differences ( $RD < 0$ ) (Figure 3, Hispanics).

Hispanics had increasing trends ( $T > 1$ ) in  $\geq 2$  of the three SES groups at all cancers and colorectal cancers for males and all cancers, colorectal and lung cancers for females. There were declining trends ( $T < 1$ ) in  $\geq 2$  of the three SES groups for lung and prostate cancer for males and breast and cervical cancer for females. There are “positive high-SES gradients” for male colorectal cancer and breast cancer. In six cancer sites, the middle-SES group (10–<20% poverty) had the best trends (Figure 1, Hispanics). Because of the strong influence of the middle-SES groups, there was little evidence of consistent SES gradients in the Hispanic data.

The positive trend differences ( $TD > 0$ ) at each SES group for each cancer site, except female lung and cervical cancers, indicate trends were worse than for whites with  $\geq 20\%$  poverty (Figure 3, Hispanics).

## DISCUSSION

Cancer health disparities in cancer mortality rates are created when beneficial biomedical interventions are not shared by everyone.<sup>11</sup> The cancer sites that we chose to examine are the sites where beneficial biomedical interventions have influenced declines in cancer mortality rates.<sup>12</sup> For lung cancer, the interventions are smoking prevention and smoking cessation programs that influence both lung cancer incidence and mortality. These interventions operate through primary prevention, the prevention of lung cancer.<sup>13</sup> For breast, cervical and colorectal cancers, the beneficial interventions begin with early detection procedures, followed by timely and appropriate cancer treatment of early-stage cancers. The early detection procedures that have been associated with declines in cancer mortality rates are mammography for breast cancer,<sup>14</sup> Pap smears for cervical cancer,<sup>15</sup> and colorectal cancer screening, such as fecal occult blood tests, sigmoidoscopy and colonoscopy;<sup>16</sup> and their appropriate cancer treatments.

Increases in the utilization of these cancer prevention and early detection procedures can be seen (Table 3). In some cases, the early detection rates are comparable, such as between white and blacks. However, there are still mortality disparities. Thus, early detection testing by itself is not enough. The results of abnormal early detection tests need to be followed up with timely and appropriate cancer treatments to take advantage of the early detection procedures.

This study measures cancer health disparities in cancer mortality rates and the impact on SES on cancer mortality rates. We discuss disparities in terms of: 1) SES gradients and cancer mortality rate trends and 2) measuring racial/ethnic disparities and the influence of SES.

## SES Gradients and Cancer Mortality Rate Trends

For whites and blacks, there were “positive high-SES gradients” for their trends at each cancer site with the highest-SES group having the best trends, in general, the largest declining trend; and the lowest-SES group having the worse trends, in general, the smallest declining trend. These are seen as the stepwise SES gradients in Figure 1 for whites and blacks. These results reflect the gradient in resources needed to obtain the beneficial biomedical interventions that can lead to declines in the cancer mortality rates.

The other racial/ethnic groups did not have “positive high-SES gradients” for all their cancer sites. For AIs/ANs, the dominant pattern was that the middle-SES groups had the worse trends in six out of nine sites (prostate and each of the five female cancer sites). This result may be due to their sources of access to their health-care. The health-care system of AIs/ANs is fragmented with the Indian Health Service (IHS), offering health-care to those in official tribes, such as those on reservations, and private insurance providers for others, while some have no insurance. Access to healthcare may be most affected by the middle-SES group that may have inadequate private insurance and may not have immediate access to IHS.

For Asians/Pis, the dominant pattern was “positive low-SES gradients” at three sites, where the highest-SES group has the worse trend and the lowest-SES group had the best trend (prostate cancer, female colorectal and lung cancers) and the “positive high-SES gradients” at three other sites (male all cancer and lung cancers and breast cancer). These results may reflect not only the influence of SES but also the influence of cultural concerns, such as language, immigration, acculturation, beliefs, perceptions and other factors associated with culture. For example, with acculturation may come an increase in SES category and an increase in the American lifestyle and diet, which may increase the risk of breast and colorectal cancers. Use of American cigarettes will increase the risk of lung cancer, which can be afforded by the highest-SES group. Knowledge about screening and beneficial medical interventions and risk of tobacco and the subsequent cessation of using tobacco products may act to reduce these risks. However, if the knowledge about screening and tobacco risks is not used, then the increased SES may lead to increases in mortality rates for this group. On the other hand, the use of free national screening and treatment programs, such as the Centers for Disease Control Breast and Cervical Cancer Demonstration Program for the lowest-SES groups and Medicare for the elderly, may help to account for the declines in the lowest-SES group.

For Hispanics, the dominant pattern was that the middle SES groups had the best trends in five of the nine sites (male all cancers and lung cancers and female all

cancer, colorectal and lung cancers). Again acculturation may cause an increase in mortality in the highest-SES group, particularly if the knowledge about screening and tobacco does not trigger cancer prevention and control actions for this group. The middle-SES groups may have the best trends since they may act on the cancer education information provided them, while the lowest-SES group may not understand the information and the highest SES may not choose to act on the information.

The patterns for SES for AIs/ANs, Hispanics and Asians/PIs indicate that their patterns are affected by more than SES factors. Culture in its many manifestations need to be considered in understanding the patterns we see by SES group. These results are consistent with the model proposed by Harold Freeman that the sources of disparities involve overlapping socioeconomic and cultural factors as well as social injustice issues.<sup>11,17,18</sup>

## Measuring Racial/Ethnic Disparities

The traditional approach of examining disparities is to measure excess cancer burden—that is, the rate for the minority is greater than the rate for the reference group, usually the white rate ( $RR > 1$ ). By this measure, blacks have RR disparities ( $RR > 1$ ) for each SES group at each cancer sites, except female lung cancer. The other racial/ethnic minorities have RR disparities for cervical cancer ( $RR > 1$ ). In addition, one can determine if the magnitude of RR disparities increased from 1990–1994 to 1995–2000 ( $RD > 0$ ). The largest number of increases in RR disparities ( $RD > 0$ ) occurs in AIs/ANs at each cancer site, except for cervical cancer. Hispanics had increases in RR disparities at seven cancer sites, each cancer site, except female lung cancer and cervical cancer. For blacks, four of nine cancer sites (colorectal cancer in males and females, prostate and breast) had increases in RR disparities. Asians/PIs had RR disparities increases for three cancer sites (male colorectal and the lowest-SES groups for breast and cervical cancers).

In identifying disparities, measuring them is the first important step, but it is necessary to understand the causes of these disparities. One way to understand these disparities is to examine the trends of cancer mortality rates for each racial/ethnic group. For blacks and whites, there are declining trends ( $T < 1$ ) for every SES group of each cancer site ( $T < 1$ ), except female lung cancer ( $T > 1$ ). Asians/PIs have similar results, except for female lung cancer and the lowest-SES groups for breast and cervical cancers ( $T > 1$ ). We see that the whites have declining trends that are greater than the trends for blacks ( $TD > 0$ ) for male and female colorectal cancers and prostate and breast cancers. Thus, the increases in rate disparities for these sites for blacks are due to the fact that the declining trends for blacks are less than the declining trends for whites for the same SES group.

In examining the trends for AIs/ANs, there are increases in trends at six of the nine cancer sites (each

cancer site, except prostate, all cancers in females and cervical cancers. Thus, six of the eight ( $RD > 0$ ) are due to AIs/ANs having increasing trends ( $T > 1$ ), while the white reference group has declining trends ( $T < 1$ ). For Hispanics, similar patterns are observed. There are increasing trends ( $T > 1$ ) for five cancer sites (all cancers and colorectal cancers for males and females and breast cancer). This causes the rate disparities' increases seen for these sites ( $RD > 0$ ) to be due to increasing trends for Hispanics. For Asians/PIs, the increases in rate disparities for the lowest-SES groups for breast and cervical cancers are due to increasing trends in their rates.

Thus, we have two mechanisms for the increases in rate disparities over time. For blacks, their declining trends are not as great as white declining trends, creating rate disparities to increase. For AIs/ANs, Hispanics and some sites for Asians/PIs, increasing trends are the source of the increases in RR disparities ( $RD > 0$ ). Therefore, by identifying disparities and their causes we have been able to better characterize and understand the nature of these disparities.

At two cancer sites—lung cancer and cervical cancer—there are declines in RR disparities over time. For lung cancer, the trends are better for male and female blacks than whites. Reducing lung cancer disparities is important for a number of reasons. First, the disparities are reduced by primary prevention—prevention of disease. Prevention programs such as smoking prevention and smoking cessation programs have first caused the lung cancer incidence to decline for blacks, then their cancer mortality rates. Clearly, a strategy that can eliminate cancer cases as the mechanism for reducing cancer mortality rates has tremendous SES impact, particularly for those with few resources. This avoids the SES issues associated with affording early detection procedures and the follow-up to cancer treatment of secondary prevention. There is still a SES gradient, but that gradient may be associated with educational and knowledge levels and the acceptance of these interventions. The fact that the lowest-SES groups for black men and women have better trends than the lowest SES for whites indicates that these issues do not prevent the reducing of these disparities. The disparities are being reduced within the existing SES structure—that is, primary prevention is affecting a reduction of disparities without changing the SES structure of the population it is addressing. These primary prevention strategies change their behaviors and the possible adverse consequences of their low SES conditions. Thus, primary prevention should be an important strategy in the arsenal of weapons to reduce cancer disparities.

There were declines in cancer disparities for cervical cancer for each racial/ethnic group ( $RD < 0$ ), except for the lowest-SES Asians/PIs. This is particular important since AIs/ANs and Hispanics had increasing trends for a number of cancer sites but declining trends for cervi-

cal cancer. Given that the beneficial biomedical interventions are Pap smears, followed by cancer treatment, the declines in trends and disparities are particularly relevant. It shows that we can get reductions in disparities in interventions that involve early detection and cancer treatment with all the associated SES issues. The CDC's National Breast and Cervical Cancer Early Detection Program, providing free screening and cancer treatment to the underserved since 1990, must be an important factor in these declines, which occurs for almost all low-SES groups. Thus, the effectiveness for national programs to affect disparities that involve the use of early detection and treatment interventions is demonstrated. Much work must still be done since we do not see declines in disparities for breast cancer.

In summary, measuring disparities begins with identifying the disparities, and two measurements are presented: the RR, comparing the rate of the minority group to the reference group, and rate disparities differences, which determine if the RRs increase over time. Then one must understand the causes of the disparities. In this case, the trends for the groups are examined to gain information on the causes of the disparities. We uncover two mechanisms for increasing rate disparities over time from the data. For blacks and Asians/PIs, their declining rates are less than the declining trends for whites, causing an increase in rate disparities over time. For AIs/ANs and Hispanics, for a number of cancer sites, they have increasing trends, rather than declining trends, that account for the rate disparities increasing over time. These are important in setting priorities for address the disparities that have been identified. By examining disparities by SES, it was observed that positive high-SES gradients affect the change in cancer mortality rates for whites and blacks but not for the other racial/ethnic groups, indicating that additional cultural factors, such as language, beliefs and traditions, environment, immigration, acculturation, etc., may influence their SES patterns and their disparities. Finally, the successful reductions in lung cancer disparities indicate that primary prevention strategies are important tools in reducing cancer disparities.

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